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To:

FISENKO, Anatoliy
625 Evans Ave.
Suite 907
Toronto, Ontario M8W 2W5
CANADA

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FISENKO, Anatoliy

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- ☐ copy of the international application as published by the International Bureau on under No. WO
- ☒ copy of international application as republished by the International Bureau on 06 January 2005 (06.01.2005) under No. WO 2004/101447
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(71) Applicant and

(72) Inventor: FISENKO, Anatolyy [CA/CA]; 625 Evans Ave., Suite 907, Toronto, Ontario M8W 2W5 (CA).

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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations
- of inventorship (Rule 4.17(iv)) for US only

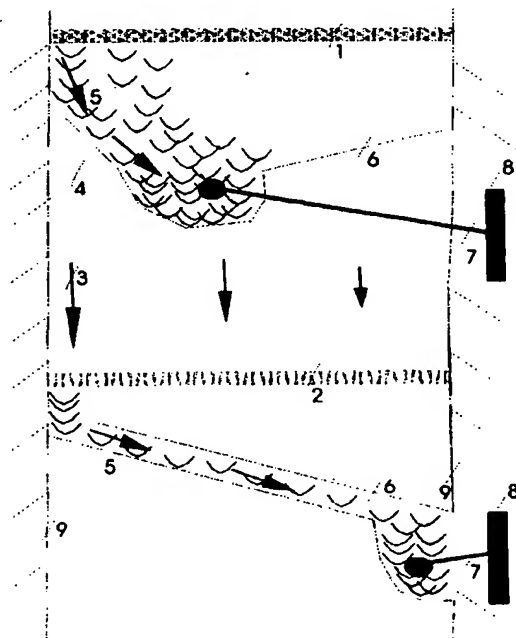
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(54) Title: A METHOD OF WATER PURIFICATION BY INDUCED FROTH (FOAM) FORMATION



(57) Abstract: A method of induced froth (foam) formation and natural purification from pollutants or contaminants for water treatment, wastewater treatment, clean-up of polluted sites of streams directly on site, clean-up of contaminated sites and any other reasons is proposed. The method utilizes the proper selected food for degrading and decomposing activities by groups of fungi, bacteria and other microorganisms which are the most resistant to the kinds of contaminants or pollutants from which water, wastewater and polluted or contaminated sites are treated or cleaned-up. While the decomposition takes place, the entire water and/or benthic soil are enriched with biological surfactants and the generated dissolved biogases and micro-bubbles of biogases. Further, the water, wastewater and polluted or contaminated sites also contain the dissolved air and all kinds of polluting particles, including man-made surfactants. By creating the proper external and/or internal conditions for forming biogases and/or air micro-bubbles and bubbles-particles aggregates in the presence of biological and/or man-made surfactants, the latter rise to the water surface and concentrate in froth and a surrounding thin top layer of surface water. The froth and surrounding thin top layer of surface water collect the contaminants or pollutants, including organic and inorganic particles with pathogens from the entire water and/or benthic soil. The froth and surrounding thin top layer of surface water are concentrated and localized in the proper designed places by any devices or equipments for further skimming off for disposal and/or redirecting to artificially created places for natural treatment directly on site and/or delivering to municipal or natural treatment facilities.

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ARTICLE 19

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AMENDED CLAIMS

received by the International Bureau on 22 November 2004 (22.11.2004)
original claims 1-7, replaced by new claims 1-7

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR
PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of induced froth (foam) formation process and natural purification from pollutants or contaminants by artificially created a complex of natural (biological and physico-chemical) self-purification processes for drinking water preparation, cleaning-up polluted sites of streams directly on site, cleaning-up contaminated sites and for any other reasons is proposed;
the said streams hereinafter mean: rivers, creeks and any other streams;
the said polluted sites of streams hereinafter mean:
the streams sites polluted from point and/or non-point polluting sources, for example, but not limited by these examples, the said streams sites polluted from the different kinds of runoff, including urban, agricultural, stored animal farms, sewage, domestic, textile and paper manufactures, mining operations and toxic, chemical spills, and other;
the said contaminated sites hereinafter mean:
the sites which could not be restored themselves by utilizing the natural self-purification processes only and man's activities are necessary,
for example, but not limited by this
example, the said contaminated site contaminated with arsenic at mining operations, uranium contaminated sites or other sites;
the said polluted sites of streams or contaminated sites hereinafter include both
the polluted or contaminated entire water and the polluted or contaminated benthic soil;
the said method utilizes:
 - a) the proper selected food or the proper selected nutrients for degrading and decomposing activities (the said biological self-purification processes) by groups of fungi, bacteria and other microorganisms to produce
the biological surfactants such as amino acids, pyruvic acids, fatty acids and other biological surfactants and
to generate
the dissolved biogases and micro-bubbles of biogases such as oxygen, ammonia, carbon dioxide, methane, nitrogen and other dissolved biogases and micro-bubbles of biogases;

or

the said proper selected food or the said proper selected nutrients are added to the said polluted sites or the said contaminated sites for promoting the said decomposing and degrading activities by groups of fungi, bacteria and other microorganisms;

b) the proper levels of turbulence or shallow-turbulence (the said physico-chemical self-purification processes) for

additional bubbles of biogases and air to be generated,

bubble-polluting particle aggregates to be formed,

both the decomposed materials from the said benthic soil enriched with the said micro-bubbles of biogases and polluting particles,

and

the said bubble-polluting particle aggregates

to be floated to water surface

or

the said proper levels of turbulence or shallow-turbulence (the said physico-chemical self-purification processes) are artificially created;

c) froth collectors installed on the top of the surface water in the proper places downstream from sites wherein the naturally

or

artificially formed froth appears;

d) the said froth collectors stop and collect the said froth and the surrounding thin top layer of surface water upstream from the said collectors in the proper places;

e) removal the said froth and the said surrounding thin top layer of surface from the said proper places for disposal, treatment or reuse.

2. A method of induced froth (foam) formation process and natural purification, as it is claimed in Claim 1, wherein the said froth collectors are constructed from the hollow water logs with or without attached metallic plates wrapped or do not wrapped in polyethylene film; the said hollow water logs with or without the said attached metallic plates are tied together and float on the top of surface water;

3. A method of induced froth (foam) formation process and natural purification, as it is claimed in Claim 1, is used for

a) cleaning –up raw water which is transported by channel to treatment facilities wherein the said proper levels of turbulence (the said physico-chemical self-purification processes) are artificially created by constructed weirs or shallow-turbulent character of water current in the said channel;

the said froth collectors are installed on the top of surface water downstream wherein the froth formed for subsequent removal or redirect;

or

b) cleaning –up raw water for drinking purpose in a Flocculation tank and a DAF tank in DAF plants wherein the said biological self-purification processes for removing organic materials is used prior to the flocculation or coagulation stage (prior to adding flocculants and coagulants) and prior to flotation by artificially promoting the decomposing and the degrading activities (the said biological self-purification processes) by groups of fungi, bacteria and other microorganisms of the said organic materials which is already presented in the said Flocculation tank or the said DAF tank in dissolved and/or suspended states;

the said artificially promoting conditions for decomposing and degrading activities (the said biological self-purification processes) is created,

for example, but not limited by this example, by keeping the said entire water at a constant temperature in the range from about 20°C – 50°C

or

the local heating is provided for keeping the local temperature in the range from about 20°C - 50°C; the said biological surfactants are produced and the said dissolved biogases and micro-bubbles of biogases are generated;

the said remain organic materials and polluting particles are removed from the said Flocculation tank and the said DAF tank by flotation;

the said method allows eliminate unintended organic byproducts which may pose health risks, and also microbial pathogens, such as *Cryptosporidium*, that are highly resistant to the disinfection of drinking water.

4. A method of induced froth (foam) formation process and natural purification, as it is claimed in Claim 1, is used for the said clean-up of polluted sites after toxic, chemical and any other spills directly on site during the time of extensive natural (the said biological and the said physico-chemical) self-purification processes wherein the said proper selected food or the said proper selected

nutrients, as it is claimed in Claim 1, are already presented in the said polluted sites as a large amount of dead organic organisms such as fish, surface organisms, pelagic organisms, bottom organisms on/in the said benthic soil;

the said dead organic organisms are served as the food for the said degrading and decomposing activities by groups of fungi, bacteria and other microorganisms which are the most resistant to pollutants spilled in the said sites of streams;

as a result of the said degrading and decomposing activities (the said biological self-purification processes)

a large amount of the said biological surfactants are produced

and

a large amount of the said dissolved biogases and the said micro-bubbles of biogases are generated in the said entire water and in/on the said benthic soil;

the man-made surfactants and the dissolved air are also presented in the said polluted sites;

the said proper levels of turbulence and shallow-turbulence (the said physico-chemical self-purification processes) for

a) additional bubbles of biogases and air to be generated

and

b) bubble-polluting particle aggregates to be formed,

and

c) both the decomposed materials from the said benthic soil enriched with both the large amount of the said micro-bubbles of biogases and the polluting particles, and the said bubble-polluting particle aggregates

to be floated to water surface

are already presented in the said streams as a water cascading over the weirs, waterfalls and shallow-turbulent character of water current or any other reasons

or

the said proper levels of turbulence and shallow-turbulence are artificially created.

the said froth in large amount with a high concentration of pollutants from the said entire water and the said benthic soil are formed downstream from the affected polluted sites with the said proper level of turbulence and shallow-turbulence;

the said froth collectors, as it is claimed in Claim 1 and Claim 2, are installed downstream from

the said affected polluted sites wherein the froth appears for stopping and collecting the said formed froth and the said surrounding thin top layer of surface water for subsequent removal for disposal or treatment during the self-restoration time;

the said self-restoration time is the time needed for the said extensive natural self-purification processes to be completed, for example, but not limited by this example, the said self-restoration time is about 3 months. This means that during 3 months the said method for the said clean-up of polluted sites after toxic, chemical and any other spills directly on site should be used; the said method of clean-up of polluted sites after toxic, chemical and any other spills directly on site using the extensive natural (the said biological and the said physico-chemical) self-purification processes during the self-restoration time is a new, supplemental one to the already existed emergency short-term clean-up methods after toxic waste spills.

5. A method of induced froth (foam) formation process and natural purification, as it is claimed in Claim 1, is used for the long-term clean-up activities of the said polluted sites polluted from different kinds of polluting source, including the said non-point ones directly on site by utilizing the natural (the said biological and the said physico-chemical) self-purification processes in the said polluted sites wherein

the said proper selected food or the said proper selected nutrients, as it is claimed in Claim 1, are presented in the said polluted sites as total organic materials in dissolved and suspended forms, and sediment which include dead organic origins (natural or originated from pollution), organic pollution and other reasons;

the said total organic materials are served as the food for the said degrading and decomposing activities (the said biological self-purification processes) by groups of fungi, bacteria and other microorganisms;

as a result of the said degrading and decomposing activities, the said biological surfactants are produced and

the said dissolved biogases and the said micro-bubbles of biogases are generated in the said entire water and in/on the said benthic soil;

the dissolved air are also presented in the said polluted sites;

the said proper levels of turbulence and shallow-turbulence (the said physico-chemical self-purification processes) for

a) additional bubbles of biogases and air to be generated

and

b) bubble-polluting particle aggregates to be formed,

and

c) both the decomposed materials from the said benthic soil enriched with both the large amount of the said micro-bubbles of biogases and the polluting particles,

and

the said bubble-polluting particle aggregates

to be floated to water surface

are already presented in the said streams as a water cascading over the weirs, waterfalls and shallow-turbulent water current

or

the said proper levels of turbulence and shallow-turbulence (the said physico-chemical self-purification processes) are artificially created;

the said froth with a high concentration of pollutants from the said entire water and the said benthic soil are formed downstream from the polluted sites with the said proper levels of turbulence and shallow-turbulence;

the said froth collectors, as it is claimed in Claim 1 and Claim 2, are installed downstream from the said polluted sites wherein the froth appears for stopping and collecting the said froth and the said surrounding thin top layer of surface water for subsequent removal for disposal or treatment or reuse,

for example, but not limited by this example, the said froth collectors installed as it is shown in Fig. 1.

the said method, as it is claimed in Claim 1 and Claim 2, is used and said froth collectors are installed:

a) downstream

from the said polluted sites such as animal and agricultural farms, sewage treatment plans, mining operation, polluting sources, sites located at the mouth of creeks, rivers and streams flowing to lakes, and other sites,

and

b) upstream

from the sites of rivers, creeks and streams wherein the intake water supplies are located;

the said long-term on site clean-up method of induced froth (foam) formation process and natural

purification, as it is claimed in Claim 1, Claim 2 and Claim 5, is a new, supplemental one to the well-known approaches such as the proper management of lands in order to reduce soil erosion, the stricter legislation to govern mining, logging, agricultural and other to prevent the pollution from different kinds of runoff (the said non-point polluting sources).

6. A method of induced froth (foam) formation process and natural purification, as it is claimed in Claim 1 and Claim 5, is used equipments for stopping the debris, including woods, tree logs and other;

the said equipments are constructed from one, two or any numbers of metallic ropes and metallic sticks and the said equipments are protruded from one bank of the said stream to another bank of the said streams, for example, but not limited by this example, the said equipments are installed in the said stream, as it is shown in Fig. 2, for stopping the said debris;

one, two or any equipments are installed along the said stream;

7. A method of induced froth (foam) formation process and natural purification, as it is claimed in Claim 1 and Claim 2, is used for the said clean-up of contaminated sites;

a principal idea of the said method is man's switching on of the natural (the said biological and the said physico-chemical) self-purification processes in the said contaminated sites;

the said proper selected nutrients as it is claimed in Claim 1, are added to the said contaminated sites, including the said entire water and the said benthic soil;

the said proper selected nutrients are served as a food for degrading and decomposing activities (the said biological self-purification processes)

by groups of fungi, bacteria and other microorganisms which are the most resistant to the contaminants from which the said contaminated sites are cleaned-up

to produce

the said biological surfactants and

to generate the said dissolved biogases and micro-bubbles of biogases;

for example,

but not limited by this example, the proper selected nutrients are added for promoting the said degrading and decomposing activities by *Pseudomonas*, *Bacillus*, *Oscillatoria* bacteria which are the most resistant to the cyanide from which contaminated sites are cleaned-up to produce the said biological surfactants and to generate the said dissolved biogases and micro-bubbles of biogases; the said contaminated water enriched with the said biological surfactants and the said dissolved

biogases and micro-bubbles of biogases is transported by pumping to artificially constructed areas or channel with weirs or shallow-turbulent character of water current to concentrate the said bubble-particle aggregates as, it is claim in Claim 1, in the froth and the surrounding thin top layer of surface water;

the said froth and the said surrounding thin top layer of surface water are skimmed off for the treatment and the treated water is transported back by pumping to the said contaminated site; the next portion of the said contaminated water from the said contaminated site is transported by pumping to the said artificially constructed area or channel;

the formed froth and the surrounding thin top layer of surface water are skimmed off and the treated water is returned by pumping to the said contaminated site;

the said long-term cycle process for cleaning-up the said contaminated sites is going on until the said natural (the said biological and the said physico-chemical) self-purification processes in the said contaminated sites are underway.

or

the said contaminated water enriched with the said biological surfactants and the said dissolved biogases and micro-bubbles of biogases is transported to the flotational tank;

the froth and the surrounding thin top layer of surface water are skimmed off and the treated water is returned by pumping to the said contaminated site;

the said long-term cycle process for cleaning-up the said contaminated sites is going on until the said natural self-purification processes (the said biological and the said physico-chemical) in the said contaminated sites are underway.